

REMARKS

At the time of the Office Action dated December 18, 2002, claims 1, 3-4, 7-13, and 19-30 were pending in this application. Of those claims, claims 1, 3-4 and 7-13 have been rejected and claims 19-30 have been withdrawn from consideration pursuant to the provisions of 37 C.F.R. § 1.142(b).

Applicants respectfully submit that by the present Amendment and Remarks, this application is placed in clear condition for immediate allowance. At the least, the number of issues have been reduced, thereby placing this application in better condition for Appeal. See M.P.E.P. § 706.07(e). For example, Applicants amendments have overcome the Examiner's objections to claims 1 and 7, the rejection of claims 3 and 4 under the first paragraph of 35 U.S.C. § 112, and the rejection of claims 1 and 7-13 under the second paragraph of 35 U.S.C. § 112. Accordingly, entry of the present Amendment and Remarks and favorable consideration are respectfully solicited.

Claim 1 has been amended to delete the reference to the second etch stop layer and to clarify that the first diffusion barrier layer and the sidewall diffusion barrier layer are formed from the same material, which is consistent with the previous clause in claim 1, which recites "said sidewall diffusion barrier layer formed by reverse sputtering of said first diffusion barrier layer." Claim 4 has been amended to clarify that a second etch stop layer is disposed on and contacts a first diffusion layer.

In the first enumerated paragraph of the Office Action, the Examiner objected to claims 1 and 7 for various informalities. As to claim 1, the Examiner asserted that "said second" should

be "a second." However, as "said second etch stop layer" in claim 1 has been removed, the Examiner's objection is moot. As to claim 7, Applicants have amended claim 1, upon which claim 7 depends, to positively recite a material for the first diffusion barrier layer. As such, antecedent basis exists for the term "said material of said first diffusion barrier layer," which is found in claim 7. Thus, Applicants submit that the Examiner's objections as to claims 1 and 7 have been overcome.

Claims 3 and 4 are rejected under the first paragraph of 35 U.S.C. § 112

In the second enumerated paragraph of the Office Action, the Examiner asserted that claims 3 and 4 contain subject matter which was not described in the specification in such a way as to enable one skilled in the art to make and/or use the invention. In particular, the Examiner asserted that the specification does not disclose a second etch stop layer disposed on and contacting the first metallization layer. This rejection is respectfully traversed.

Applicants have amended claim 4 to recite that the second etch stop layer is disposed on and contacts a first diffusion barrier layer, consistent with Fig. 3B of Applicants' specification. As such, Applicants respectfully submit that this limitation is fully supported within the specification.

Claims 1 and 7-13 are rejected under the second paragraph of 35 U.S.C. § 112

In the third enumerated paragraph of the Office Action, the Examiner asserted that claim 1 is indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. This rejection is respectfully traversed.

As the reference to the second etch stop layer has been deleted in claim 1, the Examiner's rejection as to this term is moot. Furthermore, as to lines 9-11 of claim 1, Applicants have amended claim 1 to recite that a first diffusion barrier layer and a sidewall diffusion barrier layer are formed from the same material. This is caused after the first diffusion barrier layer is sputter etched to form the sidewall diffusion barrier layer. Applicants, therefore, submit that one having ordinary skill in the art would have no difficulty understanding the scope of amended claim 1. Thus, the imposed rejection of claims 1 and 7-13 under the second paragraph of 35 U.S.C. § 112 has been overcome and, hence, Applicants respectfully solicit withdrawal thereof.

Claims 1 and 7-12 are rejected under 35 U.S.C. § 102(e) for lack of novelty as evidenced by Chooi et al., U.S. Patent No. 6,372,636 (hereinafter Chooi)

In the fourth enumerated paragraph of the Office Action, the Examiner asserted that Chooi discloses a semiconductor device corresponding to that claimed. This rejection is respectfully traversed.

In the statement of the rejection, the Examiner argued that feature 250 of Chooi corresponds to the claimed sidewall diffusion barrier layer. Feature 250 of Chooi, however, is disclosed as being formed from "amorphous silicon" (column 8, line 33). The Examiner, however, has not established that amorphous silicon would have been recognized by one having ordinary skill in the art as being a diffusion barrier layer. For example, as stated on page 5, lines 13-15 of Applicants' specification:

A problem that can be caused by the use of Cu and Cu-based alloys results from Cu having a relatively large diffusion coefficient into silicon oxide and silicon. Once Cu has diffused into these materials, Cu can cause the dielectric strength of these materials to decrease.

As is evident from this excerpt, one having ordinary skill in the art would not have considered the amorphous silicon of Chooi to be a diffusion barrier layer, as copper diffuses readily into silicon. Thus, the Examiner has improperly asserted that the amorphous silicon of Chooi discloses the sidewall diffusion barrier layer recited in claim 1.

The Examiner's analysis also relies heavily on the following statement:

Note that the term "formed by reverse sputtering" is method recitation in a device claimed, and it is non-limiting, because only the final product is relevant, not the method of making. A product by process claim is directed to the product per se, no matter how actually made. See also MPEP 2113. Moreover, an old or obvious product produced by a new method is not a patentable product, whether claimed "product by process" claims or not.

Although the Examiner has cited M.P.E.P. § 2113, the Examiner is invited to reread this particular section, as it is well-established law that product-by-process limitation must be considered by the Examiner in making a determination of novelty or obviousness.¹ Although the Examiner has a reduced burden of proof with regard to product-by-process claims, as discussed in M.P.E.P. § 2113, the Examiner must first provide a rationale tending to show that the claimed product appears to be the same or similar to that of the prior art.² However, even if the Examiner makes this reasoned argument, Applicants have an opportunity to provide evidence that establishes a difference between the product of the prior art and the claimed product.

¹ In re Luck, 177 USPQ 523 (CCPA 1973) ("it is well established that product claims may include process steps to wholly or partially define the claimed product ... [t]he method of application could well result in a difference in the coated article."); In re Brown, 173 USPQ 685 (CCPA 1972).

² "Once the examiner provides a rationale tending to show that the claimed product appears to be the same or similar to that of the prior art, although produced by a different process, the burden shifts to applicant to come forward with evidence establishing an unobvious difference between the claimed product and the prior art product." M.P.E.P. § 2113 (citing In re Marosi, 218 USPQ 289 (Fed. Cir. 1983)).

The Examiner, however, has failed to make any reasoned argument as to why the claimed sidewall diffusion layer formed by reverse sputtering is identical to the sidewall diffusion barrier layer 250 of Chooi. The Examiner has merely asserted that the claimed layer and the disclosed layer are the same without providing any rationale to support this assertion. Thus, even though the Examiner may have a reduced burden of proof with regard to product by process limitations, the Examiner has failed to even meet this reduced burden of proof. Therefore, the Examiner has failed to meet the requirements established by the case law and M.P.E.P. § 2113 regarding product-by-process limitations. Furthermore, notwithstanding the Examiner's failure to meet these requirements, the Examiner's assertion that the claimed sidewall diffusion barrier layer and the sidewall diffusion barrier layer 250 of Chooi are identical is factually in error.

As will be established below, a diffusion barrier layer formed by reverse sputtering is structurally different than the diffusion barrier layer formed by the applied prior art. As a general matter, most materials structurally differ depending upon how the particular material was fabricated. For example, the microstructure of a metal bar formed by forging, casting, powder metallurgy, extrusion, milling, or grinding are all different. As another example, a process, such as heat treating, changes the structure of a material such that the material has very different properties after heat treatment, as compared to the properties of the material prior to heat treatment. This may all occur without the composition of the material being changed. Thus, a claimed product (i.e., using a product-by process limitation) formed by a process not disclosed by the applied prior art can produce a structurally differently product than a product formed by the process of the applied prior art.

Chooi recites that the layer of amorphous silicon 250 is formed by vapor deposition (column 8, line 35-39). As is well known in the art, chemical vapor deposition (CVD) is a process that provides a conformal barrier layer. In contrast to a conventionally deposited barrier layer, a sidewall diffusion barrier layer formed by sputtering results, as recited in independent claim 1, produces a different structure than a layer formed by vapor deposition. As described in Applicants' specification on page 6, lines 1-5 and shown in Fig. 2, reverse sputtering causes ionized atoms, such as argon, to dislodge already-present material, and this material is then redeposited on other surfaces of the semiconductor device, such as sidewalls of a trench/via. The material is redeposited at varying positions on the sidewalls of the via/trench depending upon the energy imparted to the dislodged material and the direction at which the material is dislodged. For example, deposition locations immediately adjacent to the source of material (i.e., the first diffusion barrier layer) receive more material than locations farther away from the source of material.

As clearly illustrated in Fig. 3G, the redeposited material from the first diffusion barrier layer 111 forms a sidewall diffusion barrier layer 119 that is thicker closer to the first diffusion barrier layer 11 (i.e., nearer to the first metallization layer 110) and is thinner away from the first diffusion barrier layer 111. As discussed in the specification, layers 111 and 113 are reverse sputtered off to create the sidewall diffusion barrier layer 119 (page 10, lines 24-25). Thus, the sidewall diffusion barrier layer 119 of the present invention is structurally different than a conformal barrier layer formed by conventional processes.

Moreover, besides having varying thicknesses, one having ordinary skill in the art would recognize that a layer formed by reverse sputtering is different than a layer formed by other types

of deposition. In this regard, Applicants refer to U.S. Patent No. 5,417,799 to Daley et al.

(hereinafter Daley), which states:

An etching process which could be considered but is not as desirable is a conventional argon sputter etching of the surface of the substrate 10 to replicate the pattern 20 therein. This argon ion machining process has several disadvantages when compared to reactive ion beam etching. The first is the inability to produce high quality features of the required depth. With the argon sputtering process, as the groove get deeper, say on the order of 2,000 Å, material cannot make it to the top of the grooves during removal and the material redeposits on the sidewalls and in the bottom of the grooves. This redeposit of material results in the tops and sides of the grooves having a rough, textured finish which is composed of thousands of small nodules of material. These nodules are not firmly attached to the walls and sides and in the event of shock, such as thermal shock from a laser or mechanical shock, these nodules will loosen and cause failure (emphasis added)

Thus, as the redeposited material results in "a rough, textured finish which is composed of thousands of small nodules of material," Daley clearly teaches that the formation of a sidewall diffusion barrier layer by reverse sputtering produces a structurally distinct layer than a sidewall diffusion barrier formed by other methods.

Applicants, therefore, respectfully submit that the invention recited in claim 1 structurally differs from the semiconductor device disclosed by Chooi. The amorphous silicon layer 250 of Chooi does not correspond to the claimed sidewall diffusion barrier layer. Also, the Examiner has failed to consider the limitation "formed by reverse sputtering" in considering whether claim 1 is identically disclosed by Chooi. Notwithstanding this oversight, the layer 250 of Chooi is structurally different from a layer formed by reverse sputtering. As such, Chooi fails to identically describe all the limitations recited in claims 1 and 7-12 within the meaning of 35 U.S.C. § 102. Therefore, Applicants respectfully request the withdrawal of the rejection of claims 1 and 7-12 under 35 U.S.C. § 102 in view of Chooi.

Claim 4 is rejected under 35 U.S.C. § 102(e) for lack of novelty as evidenced by Zhou et al., U.S. Patent No. 6,475,810 (hereinafter Zhou)

In the fifth enumerated paragraph of the Office Action, the Examiner asserted that Zhou discloses a semiconductor device corresponding to that claimed. This rejection is respectfully traversed.

Claim 4 has been amended to clarify that a second etch stop layer is disposed on and contacts a first diffusion layer. In the statement of the rejection, the Examiner identified feature 16 of Zhou as a second etch stop layer and feature 22 as a first diffusion barrier layer. As illustrated in Fig. 6 of Zhou, however, feature 16 is not shown as being disposed on and contacting feature 22. Instead features 20 and 18 are disposed between features 16 and 22 of Zhou. Thus, Zhou fails to identically describe all the limitations recited in claim 4 within the meaning of 35 U.S.C. § 102. Therefore, Applicants respectfully request the withdrawal of the rejection of claim 4 under 35 U.S.C. § 102 in view of Zhou.

Claim 3 is rejected under 35 U.S.C. § 103 for obviousness predicated upon Zhou

In the sixth enumerated paragraph of the Office Action, the Examiner asserted that one having ordinary skill in the art would have been motivated to modify the second etch stop layer 16 of Zhou to form this layer from silicon oxide, as recited in claim 3. This rejection is respectfully traversed.

Zhou specifically recites that the stop layer 16 is formed from an organic material and preferably a low-K material (column 2, lines 57-59). Furthermore, as discussed in column 4, lines 5-20, Zhou teaches that the use of the organic layer 16 prevents the underlying interconnect 14 from

being etched and damaged, as the organic layer 16 is removed using H₂ containing down stream plasma and not by etching.

By replacing the organic stop layer 16 of Zhou with silicon oxide, which would necessitate subsequent removal by etching, the Examiner's proposed modification would be changing the principle of operation of Zhou, as Zhou teaches away from etching because etching of layer 16 would allegedly damage the underlying interconnect 14. In this regard, the Examiner is referred to the paragraph entitled "THE PROPOSED MODIFICATION CANNOT CHANGE THE PRINCIPLE OF OPERATION OF A REFERENCE" in M.P.E.P. § 2143.03.³ Thus, the Examiner cannot properly argue that the teachings of Zhou are sufficient to render the claimed invention obvious.

Claim 13 is rejected under 35 U.S.C. § 103 for obviousness predicated upon Chooi in view of Taniguchi, U.S. Patent No. 5,847,459

In the seventh enumerated paragraph of the Office Action, the Examiner asserted that one having ordinary skill in the art would have been motivated to modify Chooi in view of Taniguchi to arrive at the claimed invention. This rejection is respectfully traversed.

Applicants incorporate herein the arguments previously presented with regard to claim 1, upon which claim 13 directly depends. Specifically, Chooi fails to teach or suggest that the sidewall diffusion barrier layer is formed by reverse sputtering of the first diffusion barrier layer. The secondary reference of Taniguchi does not cure the argued deficiencies of Chooi. As such, even if

³ If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

Taniguchi and Chooi were combined, the claimed invention would not result. As such, Applicants respectfully solicit the withdrawal of the rejection of claim 13 under 35 U.S.C. § 103.

Applicants have made every effort to present claims which distinguish over the prior art, and it is believed that all claims are in condition for allowance. However, Applicants invite the Examiner to call the undersigned if it is believed that a telephonic interview would expedite the prosecution of the application to an allowance. Accordingly, and in view of the foregoing remarks, Applicants hereby respectfully request reconsideration and prompt allowance of the pending claims.

To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417, and please credit any excess fees to such deposit account.

Respectfully submitted,

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